APx511

hearing instrument analyzer

Installation Instructions,
Specifications and
Getting Started Guide

Audio precision

APx511
hearing instrument analyzer

Installation Instructions, Specifications, and Getting Started Guide

model APx511

Audio precision®

Requires APx500 v 3.3 or later.

Audio Precision
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Beaverton, Oregon 97005
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ap.com

pn 8211.0308 rev 000

XIII0514131702

Documentation and Support

This booklet contains safety information, installation instructions and full specifications for the Audio Precision APx511 hearing instrument analyzer.

A Getting Started chapter shows you basic interconnection diagrams and an introduction to controlling the APx511 with your automation software.

ap.com

Visit the Audio Precision Web site at ap.com for APx support information. APx resources are available at ap.com/downloads/apx. You can also contact our Technical Support staff at techsupport@ap.com, or by telephoning 503-627-0832 extension 4, or 800-231-7350 extension 4 (toll free in the U.S.A.).

Safety

Safety Information

Do NOT service or repair this equipment unless properly qualified. Servicing should be performed only by a qualified technician or an authorized Audio Precision distributor.

Do NOT defeat the safety ground connection. This equipment is designed to operate only with an approved three-conductor power cord and safety grounding. Loss of the protective grounding connection can result in electrical shock hazard from the accessible conductive surfaces of this equipment.

Do NOT exceed mains voltage ratings. This equipment is designed to operate only from a 50–60 Hz ac mains power source at 100–240 Vac nominal voltage. The mains supply voltage is not to exceed ±10 % of nominal (90–264 Vac).

For continued fire hazard protection, fuses should be replaced ONLY with the exact value and type indicated on the rear panel of the instrument and discussed on page 10 of this booklet.

The International Electrotechnical Commission (IEC 1010-1) requires that measuring circuit terminals used for voltage or current measurement be marked to indicate their Measurement Category. The Measurement Category is based on the amplitude of transient or impulse voltage that can be expected from the AC power distribution network. This product is classified as Measurement Category I, abbreviated “CAT I”. This product should not be used within Categories II, III, or IV. The APx511 measurement terminals are intended to be used for the measurement of audio signals only.

Do NOT substitute parts or make any modifications without the written approval of Audio Precision. Doing so may

create safety hazards. Using this product in a manner not specified by Audio Precision can result in a safety hazard.

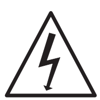
This product is for indoor use—Installation Category II, Measurement Category I, pollution degree 2.

To clean the enclosure of this product, use a soft cloth or brush to remove accumulated dust. A mild detergent may be used to remove remaining dirt or stains. Do not use strong or abrasive cleaners. Wipe all surfaces with a damp cloth.

This unit is supplied with four feet on the bottom surface and four feet on the right side surface. The unit should only be operated while resting on the bottom surface feet. The feet on the right side are provided for convenience and stability when transporting the unit. DO NOT operate the unit while it is sitting on the side feet.

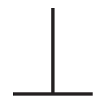
Safety Symbols

The following symbols may be marked on the panels or covers of equipment or modules, and are used in this manual:

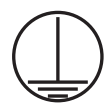


WARNING!—This symbol alerts you to a potentially hazardous condition, such as the presence of dangerous voltage that could pose a risk of electrical shock. Refer to the accompanying Warning Label or Tag, and exercise extreme caution.

ATTENTION!—This symbol alerts you to important operating considerations or a potential operating condition that could damage equipment. If you see this marked on equipment, refer to the Operator’s Manual or User’s Manual for precautionary instructions.



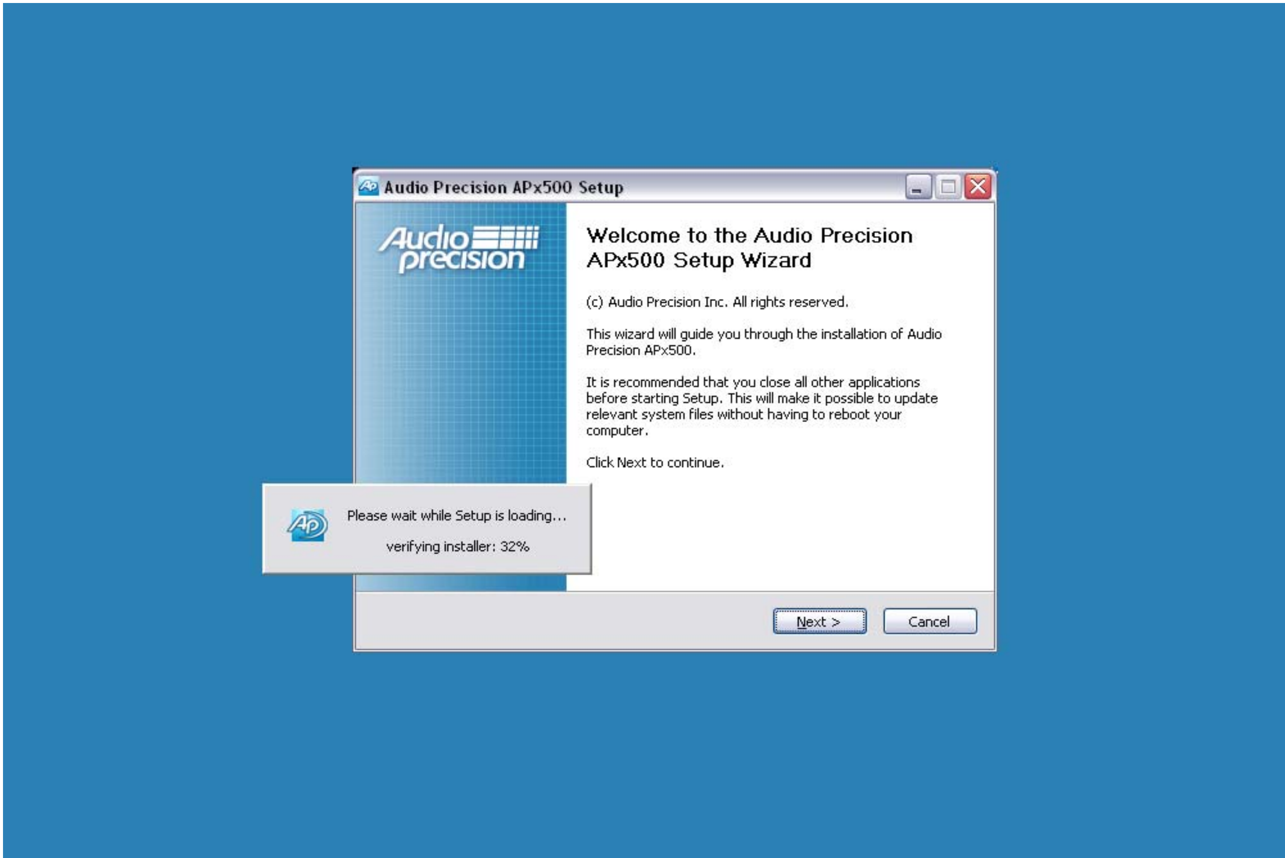
FUNCTIONAL EARTH TERMINAL—A terminal marked with this symbol is electrically connected to a reference point of a measuring circuit or output and is intended to be earthed for any functional purpose other than safety.



PROTECTIVE EARTH TERMINAL—A terminal marked with this symbol is bonded to conductive parts of the instrument and is intended to be connected to an external protective earthing system.

Disclaimer

Audio Precision cautions against using their products in a manner not specified by the manufacturer. To do otherwise may void any warranties, damage equipment, or pose a safety risk to personnel.


Audio Precision APx500 Setup
Audio precision
Welcome to the Audio Precision APx500 Setup Wizard
(c) Audio Precision Inc. All rights reserved.
This wizard will guide you through the installation of Audio Precision APx500.
It is recommended that you close all other applications before starting Setup. This will make it possible to update relevant system files without having to reboot your computer.
Click Next to continue.
Please wait while Setup is loading...
verifying installer: 32%
Next >
Cancel

Installation

Software

The APx511 hearing instrument analyzer system uses the award-winning APx500 measurement software, whether using the GUI in the foreground, or controlling APx500 in the background using the API. This is the same software used in the APx525and APx585 analyzer families.

PC system requirements

The APx500 measurement software requires a personal computer (PC) with the following features and capabilities:

- Operating system: Microsoft Windows 8, Windows 7, Windows Vista, or Windows XP Professional (Service Pack 2 or later).
- A multi-core processor (at least dual-core) running at a clock speed of at least 2 GHz. Most current processors from Intel and AMD meet these requirements.

Note: the Intel Atom processor does not meet our minimum specification.

- At least 2 GB of RAM.
- At least 300 MB of free hard disk space.
- A CD-ROM optical disc drive.
- A USB 2.0 port; two are required for optional switcher use.
- A color monitor and a video card with at least VGA capabilities. Video resolution of 1024 x 768 or greater is recommended.

System performance is sensitive to processor speed; faster processors will yield faster results.

APx500 is data intensive and it is recommended that other data-intensive applications not be run concurrently. This includes Audio Precision's AP2700, APWIN or ATS.

Installation

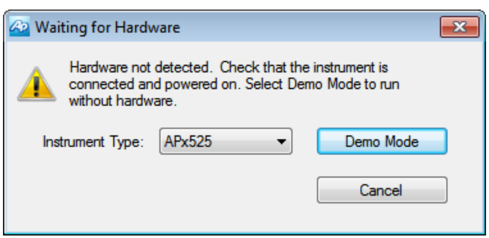
To install the measurement software, insert the APx500 CD-ROM into the optical drive on the PC and follow the instructions in the installation dialog.

> *NOTE: You must have local administrator rights to install APx500 software. Go to User Accounts in the Windows Control Panel, or check with your network administrator.*

Running the software without instrument hardware attached

> *NOTE: You must have standard user rights or administrator rights to operate APx500 software. Guest users are not supported.*

You can launch the APx500 software without instrument hardware attached. When no hardware is detected, APx500 will present you with the following dialog box:



Select "Demo Mode." APx500 will run in demo mode, which allows you to explore the user interface but does not enable any measurement functions. Input data shown in Demo Mode is false data, generated for display only.

At first launch, Demo Mode runs simulating attachment to an APx585. To run Demo Mode simulating anther instrument, select that option from the Instrument Type menu. The APx511 instrument is not an available option in Demo Mode.

Running the software with instrument hardware attached

> *NOTE: You must have standard user rights or administrator rights to operate APx500 software. Guest users are not supported.*

Connecting the instrument to your PC

Before connecting your APx511 instrument to your PC, install the APx500 measurement software as described above. Connecting the instrument prior to software installation may cause Windows to select an incorrect USB driver for the instrument.

USB driver selection

The measurement software communicates with the APx511 using a USB 2.0 interconnection. Once the software is successfully installed, connect one end of the USB cable to a USB 2.0 port on the PC, and the other end to the PC INTERFACE port on the rear of the APx515. We strongly recommend that you use the USB cable included with your instrument (AP part number CAB-APSI). We have tested other USB cables that perform poorly.

> *Note: Some PCs have optional USB ports on the front of the PC, or on extension brackets on the rear. In many cases these convenience ports have compromised performance due to the extra cable length within the PC. We recommend using*

USB ports directly connected to the PC motherboard, typically at the rear of the PC.

Connect the APx511 mains power cord to the instrument and to a source of ac mains power. See **Setting up the hardware** below for more information about mains connections.

Turn the instrument on by rocking the mains power switch up to **ON** (|). The mains power switch is located in the power entry module on the rear of the APx511. Windows will detect the presence of the APx511 on the USB port and will open the Hardware Update Wizard to search for the correct software driver. Select “Install the software automatically.” Windows will find the Audio Precision driver software installed with APx500 and connect to the APx511.

Launch APx500 by double-clicking on the installed shortcut. With the APx511 connected, you may be asked to update the instrument firmware during the first launch of the measurement software. APx500 will start, and in a short time you will be presented with the opening screen. Refer to the APx500 User’s Manual for more information about making measurements.

The APx500 User’s Manual is available as a PDF on the APx500 Application Disc and online at ap.com; a hard-copy version can be ordered from Audio Precision or your local distributor.

Setting up the hardware

Connecting your instrument to the electrical mains supply

The APx511 instrument must be connected to a 50–60 Hz alternating current (ac) electrical mains supply, maximum voltage 250 Vrms.

The instrument has been configured at the factory for the expected voltage at its intended destination, as ordered. The voltage setting and fusing arrangement will normally be correct unless the instrument has been transported into another area. The power entry module has a strip of indicator tape showing its mains voltage setting. This tape must be removed before use.

*You **MUST** be sure that the APx511 instrument mains power configuration is correct for the electrical mains power supplied in your area. If you are not sure, do not plug the instrument into the mains power. Follow the instructions below to check or change the instrument mains supply voltage selection.*

The mains power supply is applied to your APx511 instrument through the power entry module located on the rear panel. Before connecting the power cord, confirm that the input voltage selection and fusing arrangement in the power entry module are correct for your mains power supply.

Figure 2. Detail of power entry module on APx511 instrument rear panel.

The mains power switch is to the left.

Checking the mains supply voltage configuration

The white plastic voltage indicator pin protrudes through one of the four labeled holes in the module cover to indicate the selected input voltage. Figure 2 shows the pin in the second position, indicating 120 V. Check to see that the indicated voltage matches your mains supply voltage. If it does not, change the mains supply voltage configuration as described below.

Opening the power entry module

Unplug the power cord from the instrument before changing fuses or performing any other operations described in this section.

To open the power entry module, refer to Figure 3 and proceed as follows:

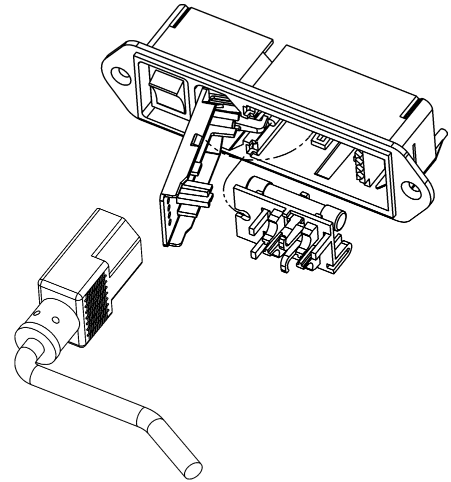


Figure 3. Power entry module door and fuse block.

- Remove the mains power supply cord from the power cord connector.
- Locate the slot in the module cover door hinge. The hinge is a the left side of the cover door, and the slot in the hinge is visible in the power cord connector cavity. Insert a small screwdriver or similar tool in the slot and pry the cover door hinge outward. The cover door will snap out, and then can be pivoted on its hinge for access to the fuse block assembly and voltage selector card.

Changing the Mains Supply Voltage Configuration

- Open the Power Entry Module as described above.
- The voltage selector card is a small circuit board fitted with a white plastic indicator pin, installed in a housing on the right side of the Power Entry Module as shown in Figure 4. Pull the voltage selector card straight out of the housing, using narrow pliers to grab the card. Do not use the indicator pin as a handle.

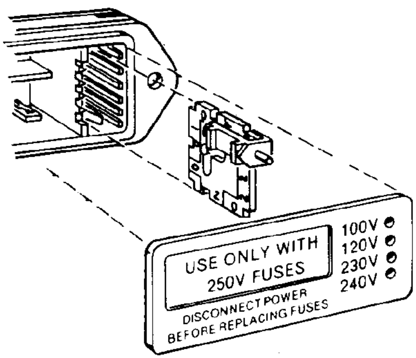


Figure 4. Changing the mains power supply voltage.

- Orient the selector card so that the desired input voltage is readable at the bottom, shown in Figure 5. Then move the indicator pin to point UP, opposite the indicated voltage. Seat the pin assembly in the notch on the board edge.
- Insert the voltage selector card into the housing with the printed side of the card facing toward the mains power connector. The card edge indicating the desired voltage should enter the housing first.
- Confirm that the correct fuse or fuse combination is installed for the intended input voltage (refer to the fuse ratings marked on the instrument rear panel). If necessary, change the fuse type as described in the following section.

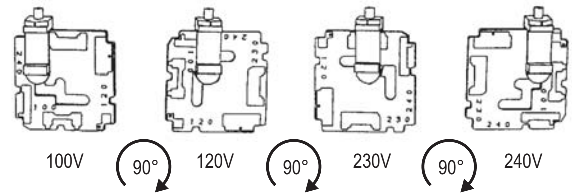


Figure 5. Voltage card selector orientation.

- Close the module the cover door and verify that the indicator pin shows the desired voltage.
- Once you have verified that the line voltage selection is correct, connect the power cord from a mains power outlet to the power cord connector on the instrument rear panel.

Fuse information

The power entry module accommodates two fusing arrangements, as illustrated in Figure 6.

100/120 VAC operation

The 100/120 VAC fusing arrangement uses a single type 3AG (0.25" x 1.25") slo-blo fuse. Audio Precision recommends only the following replacement fuse:

- 1 each Littelfuse 313 Series, 800 mA 3AG 250 V slo-blo glass fuse.

230/240 VAC operation

The 230/240 VAC fusing arrangement uses two 5 x 20 mm IEC-approved type T fuses. Audio Precision recommends only the following replacement fuses:

- 2 each Littelfuse 213 Series, 400 mA 250 V 5 x 20 mm Time Lag (slo-blo) glass fuses
  or
- 2 each Littelfuse 218 Series, 400 mA 250 V 5 x 20 mm Time Lag (slo-blo) glass fuses.

Refer to the label on the instrument rear panel for fuse current ratings.

Changing the fusing arrangement

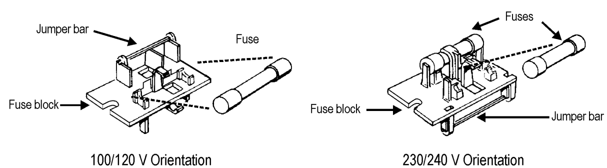


Figure 6. Fuse block orientation for 100/120 VAC and 230/240 VAC operation.

To replace a fuse or change the fusing arrangement, proceed as follows:

- Remove the mains power cord from the power cord connector and open the Power Entry Module as described above.
- Using narrow pliers, pull the fuse assembly out of the housing.
- Change or add the correct fuses as necessary, referring to Figure 6. Refer to the instrument rear panel for the correct fuse electrical current rating.
- Insert the fuse assembly in the housing, with the side of the assembly that carries the fuse(s) for your desired fusing arrangement facing into the housing. Press the fuse assembly firmly into the housing.
- Confirm that the line voltage selection is correct for your mains voltage and your fusing arrangement.

Once you have verified that the line voltage selection is correct, connect the power cord from a mains power outlet to the power cord connector on the instrument rear panel.

Specifications
APx511 hearing instrument analyzer

with APx500 v3.3 or higher measurement software
March 2013   NP0020.00020 r000

Characteristic	Specifications	Supplemental Information
ANALOG GENERATOR		
Number of Channels	2, independent amplitude control	*Speaker and telecoil output on DB-15 on rear panel*
Waveforms	Sine, continuously swept-sine, noise, IMD test signals, multitone, wave file playback	
Sine Characteristics		
Frequency Range (Fs)	100 Hz to 20 kHz	*Setting resolution is typically 45 µHz*
Frequency Accuracy	±(0.0003% + 100 µHz)	
Amplitude Range (Speaker)	0 to 5.7 V rms [16.1 Vpp] into 8 Ω	*4 W into 8 Ω*
Amplitude Range (Telecoil)	0 to 110 mA rms into 4 Ω	
Amplitude Accuracy, 1 kHz Speaker Output	±0.05 dB [±0.60 %]	
Amplitude Accuracy, 1 kHz Telecoil Output	±0.1 dB [±1.0 %]	
Flatness (1 kHz ref)		
100 Hz to 10 kHz	±0.05 dB	
10 kHz to 20 kHz	±0.1 dB	
Residual THD+N[1,2]		
Fs = 100 Hz–20 kHz	≤ (–80 dB + 1.4 µV), 20 kHz BW	*Typically ≤0.005% THD+N*
Non-Harmonic Content		*Typically ≤110 dB when Fs ≤20 kHz*

Characteristic	Specifications	Supplemental Information
Noise Characteristics		
Shape	White (<5 Hz to 0.45*SR), Pink (<10 Hz to 0.45*SR), IEC 60268-1 or BS EN 50332-1	
Amplitude Range	0 to 16.12 Vpp	*Amplitude calibration is approximate*
IMD Test Signals		
SMPTE & MOD		
LF Tone Range	100 Hz to 1 kHz	
HF Tone Range	2 kHz to 10 kHz	*HF tone must be ≥ 6 • LF tone.*
Mix Ratio (LF:HF)	10:1, 4:1 or 1:1	*4:1 maximum with SMPTE signal.*
Amplitude Range	0 to 16.12 V pp, speaker output; 0 to 310 mA pp, telecoil output.	
Amplitude Accuracy	±0.06 dB [±0.70%]	
Residual IMD^{1,2,3}	≤0.01% [–80 dB], 4:1 mix ratio	
DFD		
Tone Pair Mean Range	2.5 kHz to 10 kHz	$F_{mean} = (F1 + F2)/2$.
Tone Pair Difference Range	100 Hz to 2.0 kHz	$F_{diff} = \|F2 - F1\|$ F_{mean} *must be* $\geq 6 \bullet F_{diff}$
Amplitude Range	0 to 16.12 V pp, speaker output; 0 to 310 mA pp, telecoil output.	
Amplitude Accuracy	±0.06 dB [±0.70%]	
Residual IMD^{1,2,3}	≤ 0.01% [–80 dB]	
Multitone, Wave File Playback		
Sample Rate Range (SR)	8 kS/s to 108 kS/s, and 175 kS/s to 192 kS/s	*Operation from 109 kS/s to 175 kS/s is possible, but with degraded flatness*
Maximum File Size	32 MSample.	
Amplitude Range	0 to 16.12 V pp, speaker output; 0 to 310 mA pp, telecoil output.	*.Wav file must peak at digital full scale to obtain selected amplitude*
Flatness (1 kHz ref)		
SR = 175 kS/s to 192 kS/sec		*Typically <0.012 dB to 20 kHz*
SR = 8 kS/s to 108 kS/s		*Typically <0.04 dB to 20 kHz; max frequency limited to ≈0.45 • SR*
Spurious Content		*Typically <–100 dB*

Characteristic	Specifications	Supplemental Information
Max Output Current		*speaker output current limit typically 1.5 A peak min*
ANALOG ANALYZER		
Number of Channels	1 auto-ranging.	*Max ADC sample rate = 192 kS/s*
Maximum Rated Input	48 V pp, 24 V dc	
Input Impedance		
Unbalanced	100 kΩ || ≈230 pF to BNC shield	*BNC shield to instrument chassis ground.*
Input Coupling	AC	*Typically <0.5 dB roll-off at 20 Hz*
Input Ranges	250 mV rms to 80 V rms, 10 dB steps	
Level (Amplitude) Measurement		
Microphone Input		
Range	< 1 µV to 16.9 Vrms	
Accuracy (1 kHz)	±0.05 dB [±0.60 %]	
Flatness (1 kHz ref)		
100 Hz to 10 kHz	±0.05 dB	
10 kHz to 20 kHz	±0.1 dB	
Speaker Voltage		
Range	< 1 µV to 5.7 Vrms	*Limited by speaker amplifier output*
Accuracy (1 kHz)	±0.05 dB [±0.60 %]	*Open circuit with no load applied*
Flatness (1 kHz ref)		
100 Hz to 10 kHz	±0.05 dB	*8 Ω load*
10 kHz to 20 kHz	±0.1 dB	
Telecoil Input		
Range	< 1 µA to 110 mA rms	*Limited by telecoil output*
Accuracy (1 kHz)	±0.1 dB [±1.0 %]	*With 1 Ω load applied*
Flatness (1 kHz ref)		
10 Hz to 10 kHz	±0.05 dB	*With 1 Ω load applied*
10 kHz to 20 kHz	±0.1 dB	

Characteristic	Specifications	Supplemental Information
THD+N Measurement (Microphone, Speaker Voltage, Telecoil Current)		
Fundamental Range	100 Hz to 20 kHz	
Measurement Range	0 to 100%	
Accuracy	±0.5 dB	
Residual THD+N[1,2]	≤ (–80 dB + 1.4 μV), 20 kHz BW	*Microphone, speaker and telecoil*
Level & THD+N Filters		
High-Pass	5 Hz to 500 Hz, or None	*1 Hz steps*
Low-Pass[4]	2.7 kHz to 90 kHz, or None	*100 Hz steps; very sharp roll-off characteristic exceeds AES-17*
Weighting	A-wt, C-wt, CCIR-1k, CCIR-2k, CCITT, C-message, 50 μs or 75 μs de-emph (with and without A-wt), or None	*Weighting filter is cascaded with the high-pass and low-pass bandwidth limiting filters*
IMD Measurement		
Test Signal Compatibility		
SMPTE & MOD	Any combination of 100 Hz–1 kHz (LF) and 2 kHz–10 kHz (HF), mixed in any ratio from 1:1 to 10:1 (LF:HF)	*HF tone must be ≥ 6 • LF tone.*
DFD	Any two-tone combination with mean frequency of 2.5 kHz–10 kHz and a difference frequency of 100 Hz–2.0 kHz	$F_{mean} = (F1+F2)/2$, $F_{diff} = \|F2–F1\|$. F_{mean} must be $\geq 6 \cdot F_{diff}$
IMD Measured		
SMPTE	Amplitude modulation of HF tone.	*Measurement BW is typ. 40–500 Hz.*
MOD	d2, d3, d2+d3, or d2+d3+d4+d5	*Use "d2+d3" for meas. per IEC 60268*
DFD	d2, d3, d2+d3, or d2+d3+d4+d5	*Use "d2+d3" for meas. per IEC 60268*
Measurement Range	0 to 20%	
Accuracy	±0.5 dB	
Residual IMD[1,2,3] (Speaker to Microphone, Speaker Voltage, Telecoil Current)		
SMPTE & MOD	≤–80 dB [0.01 %], 4:1 mix ratio	
DFD	≤–80 dB [0.010 %]	

Characteristic	Specifications	Supplemental Information
Frequency Measurement		
Range	100 Hz to 20 kHz	
Accuracy	±0.0003% [3 ppm]	*V_{in} must be ≥ 5 mV.*
Resolution	6 digits	
DC Voltage Measurement		
Input Ranges	0.25 V to 80 V, 10 dB steps	*±24 Vdc maximum in 25 V range*
Accuracy		
250 mV and 800 mV ranges	±(0.7% reading + 1 mV)	
2.5 V to 80 V ranges	±(0.7% reading + 0.1% range)	

Battery simulator

Characteristic	Specifications	Supplemental Information
Number of outputs	1 on DB15 connector on rear panel	
Battery output specifications		
DC output range	0 to 2.048 Vdc	*Resolution typically 1 mV*
Resolution	≤ 15 mV	
Accuracy	±15mV	
DC output impedance	4.3 ohms ± 5%	
Noise	≤ 1 mV pp over 10kHz BW	
DC output current	≥ 30 mA dc	
Battery current measurement		
Current measurement range	0 to 30 mA	
Resolution	10 µA	
Accuracy	±5 %	*Release 3.3 and greater.*

Characteristic	Specifications	Supplemental Information
GENERAL/ENVIRONMENTAL		
Power Requirements	100, 120, 230 or 240 Vac, 50–60 Hz, with safety ground via approved power cord, 75 VA max.	*Typical operating range is 90–110 Vac (100V), 108–132 Vac (120V), 198–242 Vac (230V), or 216–264 Vac (240V).*
Temperature Range		
Operating	0° C to +45° C	
Storage	–40° C to +75° C	
Humidity	90% to +40° C (non-condensing)	
Max Operating Altitude	3,000 m	*Derate max operating temperature above 2,000m by 1° C per 200m*
Stabilization Time	20 minutes	*Allow at least 60 minutes if unit has been stored in a significantly different environment prior to turn on, or if unit is to be calibrated or adjusted*
EMC	IEC 61326-1:2005 / EN 61326-1:2006. Complies with EC Council Directives 2004/108/EC and 93/68/EEC.	*Emission and immunity levels are influenced by the shielding performance of interface and signal cables attached to the instrument. EMC compliance was demonstrated using Audio Precision cables*
Safety	IEC 61010-1:2001 / EN 61010-1:2001, CAN/CSA-C22.2 No. 61010-1-04, and UL Std No. 61010-1 (2nd Edition). Complies with EC Council Directives 2006/95/EC and 93/68/EEC.	*Equipment Class I, Installation Category II, Pollution Degree 2, Measurement Category I*
Dimensions		
Width	374.5 mm (14.75 inches)	*Including handle*
Height	79 mm (3.11 inches)	*2U rack mount tray available.*
Depth	413 mm (16.27 inches)	*Increase by ≈8mm [0.3 inches] if rear panel option keys are installed*
Weight	4.5 kg [9.9 lbs]	

Notes to Specifications

1. System specification including contributions from both generator and analyzer. Generator-only and/or analyzer-only contributions are typically less.
2. Generator load must be ≥ 8 Ω (speaker output), or ≤ 4 Ω telecoil output for specified performance.
3. Analyzer input must be ≥ 150 mV for specified performance. Analyzer set to measure “d2+d3” IMD products for MOD and DFD modes.
4. Maximum low-pass filter frequency is limited by analyzer input bandwidth setting.

Characteristic	Specifications	Supplemental Information

Getting Started Guide

Overview

The APx511 is an analog-only audio analyzer with connectivity and features specifically designed to test hearing instruments. The front panel provides 5 LED indicators, and the rear panel provides all the audio, control and mains power connections, and the mains power switch.

Hearing instrument testing is typically accomplished using a test chamber such as the Interacoustics TBS25. The chamber is fitted with an internal loudspeaker and a telephone magnetic field simulator (TMFS, or telecoil) for telecoil stimulation, and provides a means of connection for a measurement microphone / acoustic coupler combination and a battery simulator, both provided by the user.

The APx511 has an internal 4 watt power amplifier to drive the loudspeaker, a telecoil output, a powered microphone input and DC connections for the battery simulator.

See the Installation chapter earlier in this booklet for information about software installation, mains power connection and fusing. See the Specifications chapter for a detailed listing of the APx511 capabilities and characteristics.

Software control

The analyzer hardware runs under Audio Precision's APx500 measurement software. Although it is possible to use the APx511 with the APx500 user interface, a more typical use is to address the APx500 API using proprietary automation software, with APx500 running in the background.

A .NET library of functions to perform and automate the tests described in IEC60118-7 and ANSI S3.22 is provided, with programming samples in LabVIEW, VB.NET and C#, and a program to illustrate usage of the DLL. See page 29.

Front Panel Indicators

There are 5 LED indicators on the APx511 front panel. From left to right, these are:

POWER

This indicator is lit when mains power is applied.

SPEAKER

This indicator is lit when the Speaker output is selected.

TELE-COIL

This indicator is lit when the Telecoil output is selected.

BATTERY

This indicator is lit when the battery reference voltage is on.

MIC

This indicator is lit when power is applied to the microphone input.

Rear Panel Connections

All connections to and from the APx511 are provided on the rear panel. From left to right these are:

Power Input Module

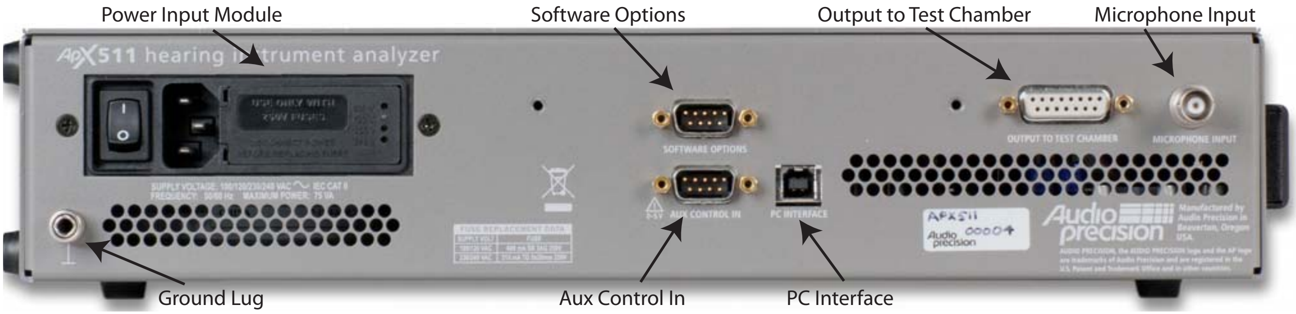
The mains switch, the mains power input and mains line fusing are provided in the module. See the Installation chapter earlier in this booklet for detailed information.

Ground connection

This ground lug provides a convenient point to bond the chassis and technical ground of the APx511 to other equipment as part of a test setup.

Software Options

The APx511 is provided with all the software features and measurements required for hearing instrument testing. If you also require PESQ or POLQA testing, optional software keys can be purchased. The software keys are connected at the Software Options connector.



Aux Control In

Aux Control (sometimes referred to as GPIO) provides the capability to communicate with external devices by transmitting and receiving control commands. The APx511 supports Aux Control Input only.

Aux Control In is a general-purpose 8-bit digital port, available on a 9-pin D-Sub connector. Pin 9 is the common (ground) connection; pins 1–8 are numbered to correspond with the Aux Control bits 1–8.

Aux Control In commands can be read in the APx500 software, or can be used to trigger actions in an APx500 sequence. Applications include input of operator controls (such as a foot switch) and reading of device states.

PC Interface

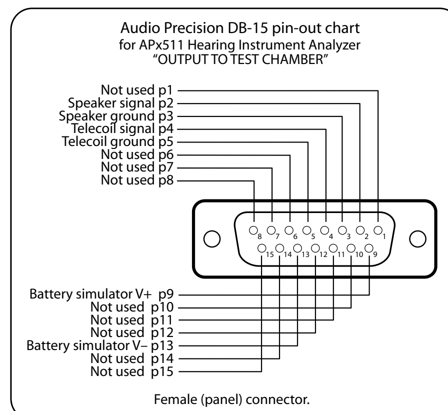
Use this connector to connect the APx511 to a USB port on the PC running APx500.

Output to Test Chamber

This connector provides connectivity to elements in the test chamber, as shown in the diagram on the opposite page, and are detailed in the connector pin-out diagram shown here.

Microphone Input

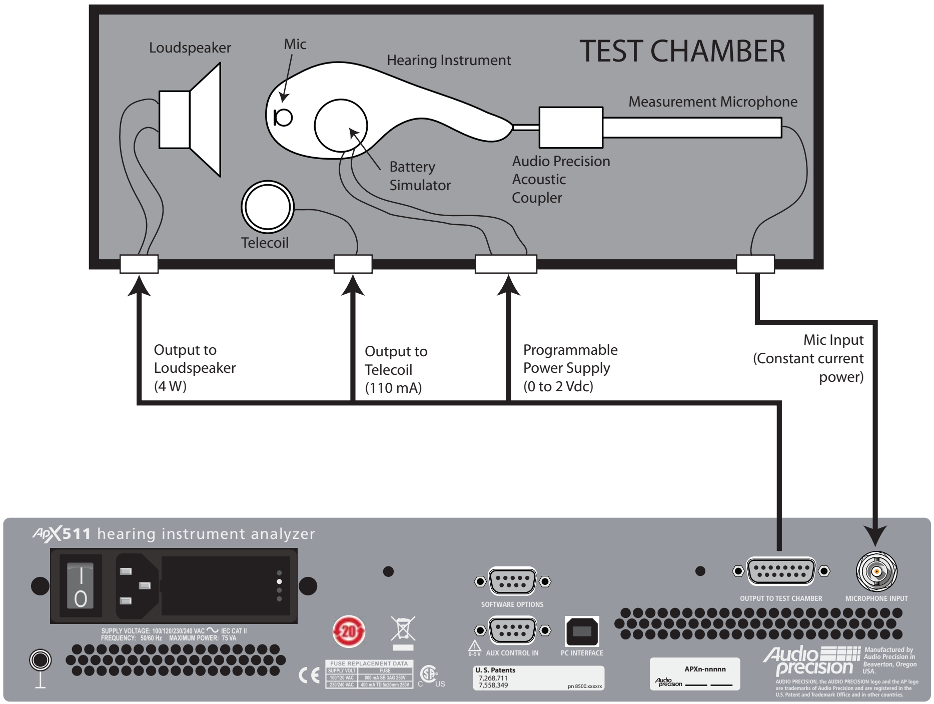
Connect the measurement microphone to this BNC connector. The APx511 is designed to be used with a prepolarized measurement microphone that uses constant current power (CCP). A 24 Vdc, 4 mA constant current power source to power the microphone can be switched ON or OFF in software.



Basic Test configuration

Hearing instrument testing is typically performed in an acoustically isolated test chamber, which is fitted with a loudspeaker, a telecoil, a battery simulator and a measurement microphone with a 2 cc acoustic coupler.

The APx511 is shipped with either a DB-15 to DB-15 cable, or a DB-15 breakout cable, selected at time of purchase. Use this cable to connect the elements in your test chamber to the APx511 as shown in this diagram. The microphone cable shown here is provided with the measurement microphone, when purchased as an option from Audio Precision.



Accessories

Measurement microphone, dummy mic, HA-1 and HA-2 couplers.

Audio Precision offers these accessories for the APx511:

- Measurement Microphone, 0.5 in. diameter.
- Measurement Microphone, 14 mm diameter.
- Microphone coupler, 2 cc, HA-1-05, 0.5 in.
- Microphone coupler, 2 cc, HA-2-05, 0.5 in, with BTE tubes.
- Microphone coupler, 2 cc, HA-1-14, 14 mm
- Microphone coupler, 2 cc, HA-2-14, 14 mm, with BTE tubes.
- Dummy mic, 0.5 in diameter
- Dummy mic, 14 mm diameter
- Microphone calibrator, 0.5 in fitting
- Calibrator adapter, 0.5 in. to 14 mm
- APx511 Self test kit

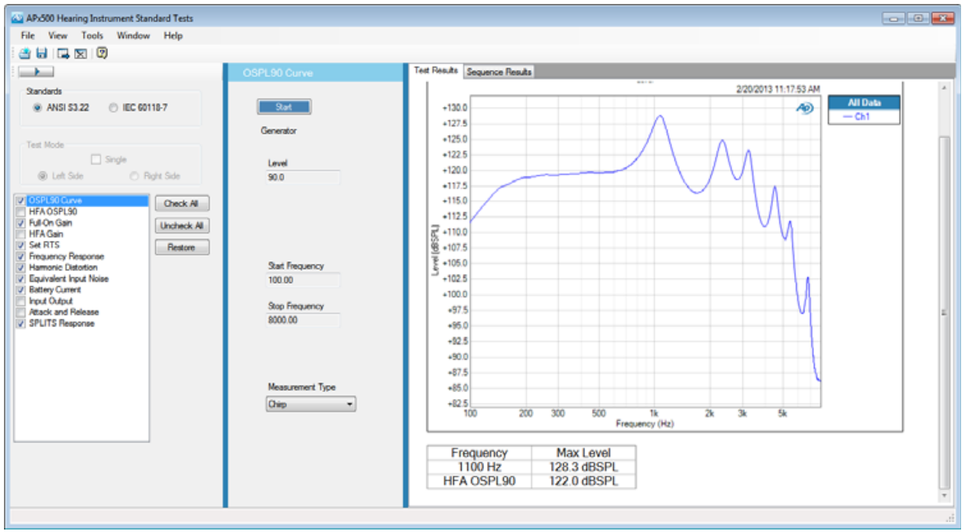
G.R.A.S. Microphone Calibrator

Please contact your representative or Audio Precision for more information.

APxHia

We have included a program called APxHia to illustrate the hearing instrument testing functions available in the .NET function library.

The program provides tools for microphone calibration and chamber leveling and other common tasks. It also runs a series of tests satisfying the two defining standards for hearing instrument testing.



Note that APxHia is provided for illustrative purposes only. For production testing a user-created program in C#.NET, VB.NET or LabVIEW should be created to address the API. See page 29.

The graphs displayed in APxHia are images. To access the graph data, go to the corresponding graph in the APx500 user interface.

Running APxHia

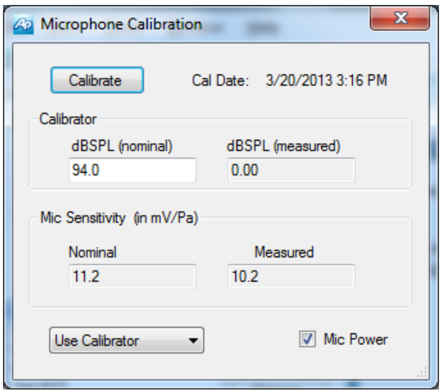
In the **Windows Start menu** under **Audio Precision** > **APx500 3.2** > **HearingInstrumentTest**, choose **APxHia Test**.

When APxHia first launches, it also launches APx500 (in the background, not visible) and opens an APx project file. If APxHia has been run on this system before, previous settings are read and applied.

From the APxHia **View** menu, choose **APx500** to make APx500 visible. If you are familiarizing yourself with the APx511, it can be instructive to watch the APx500 displays while the testing progresses.

You can also choose to turn the APx signal monitors ON or OFF from the **View** menu. The signal monitors consume considerable PC resources, and you may find that your system is more responsive with the monitors off.

Calibrating the microphone



A first step is to set microphone calibration for the system. Go to **Tools** > **Microphone** to open the **Microphone Calibration** dialog. If the microphone has been previously calibrated with this system, the calibration date will be shown.

Using a Calibrator

APxHia provides two methods of obtaining calibration references. The preferred method is to use a third-party microphone calibrator device. Choose **Use Calibrator** form the **Reference** menu.

Microphone calibrator devices typically provide acoustic output levels of either 94 dBSPL or 114 dBSPL. Enter the calibrator output level in the **dBSPL (nominal)** field.

Check the **Mic Power** checkbox to apply power to the microphone. With APx visible, you can verify connections and power by tapping the microphone while watching the Level display in APx500.

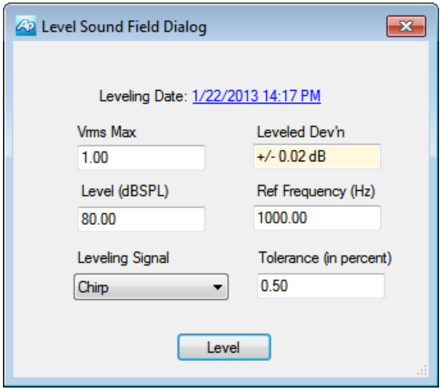
Fit the microphone to the calibrator and turn the calibrator ON. In APxHia, Click **Calibrate**.

The program will measure the microphone output and set **Mic Sensitivity (measured)** value as required to calibrate the microphone.

Bypassing acoustic calibration

If you do not have a microphone calibrator, you can bypass acoustic calibration and instead enter the microphone sensitivity from the microphone specification sheet.

Leveling the test chamber



This tool will set chamber acoustic output to a calibrated level, and equalize the analyzer output to compensate for loudspeaker response.

If no leveling data is on file for this system, the **Leveling Date** field will read "No Leveling Data."

Leveling uses the regulation function in APx.

Put the microphone on the chamber test point spot. Fit the dummy mic to the coupler to maintain a constant acoustic space. Close and seal the chamber.

Click **Level**. The program finds the generator level required to achieve the target level and sweeps the chamber at that level. A compensation curve is created and applied to the generator output. The chamber is swept again with leveling compensation, and the maximum deviation from flat response at the reference frequency is shown in the Leveled Deviation field.

Preparing the DUT

For testing purposes, hearing instruments are considered to be one of two types: "behind the ear" (BTE), which uses a short acoustic tube to route the instrument output to the ear canal, and "in the ear" (ITE) which outputs sound directly into the ear canal.

Fit the appropriate microphone coupler to the acoustic output of your device under test (DUT). Fit the measurement microphone into the coupler.

Powering the DUT

For testing purposes, the internal battery is replaced with a battery simulator (or *pill*). Fit the battery simulator into the DUT and connect it to the battery adapter jack within the chamber.

Testing the Acoustic input

The hearing instrument is typically tested in an acoustic chamber, where a loudspeaker stimulates the instrument's receiver (internal microphone). Set the DUT in the chamber's optimal acoustic test point (the "sweet spot"), and attach the microphone coupler and measurement microphone.

Set the DUT's program switch to acoustic mode.

Testing the Magnetic input

The acoustic chamber is also fitted with a telephone magnetic field simulator (TMFS, or telecoil) to induce a signal into the DUT's telecoil input. The optimal placement of the DUT for magnetic coupling must be discovered by trial, as described in the procedure below.

For telecoil testing, set the DUT's program switch to telecoil mode.

Running the standard tests

Place the DUT (with the battery simulator installed), the measurement microphone/coupler combination and the dummy mic in the chamber.

Follow the prompts in the measurements to set the DUT volume control to the correct level.

ANSI S3.22 / IEC60118-7

Hearing instrument testing is defined in two standards: ANSI S3.22 from the American National Standards Institute, based in Washington, D.C., and IEC60118-7, from the International Electrotechnical Commission based in Geneva, Switzerland.

The two standards are largely the same, with only a few minor differences in methods, values and nomenclature. Refer to the standard of interest for an explanation of terms and procedures.

APxHia provides a series of measurements for each standard, selectable by the Standards buttons.

Measurements for ANSI S3.22

These ANSI S3.22 measurements are supported:

OSPL90 curve

OSPL90 Curve measures coupler output sound pressure level (OSPL) as a function of frequency, for a 90 dB input SPL.

HFA OSPL90

HFA OSPL90 displays the high frequency average (average SPL at 1 kHz, 1.6 kHz and 2.5 kHz) for a 90 dB input SPL.

Full-On Gain

Full-On Gain (FOG) displays gain for an input of 60 dBSPL when the gain of the hearing instrument is at its full-on position.

HFA Gain

HFA Gain displays the HFA gain for an input of 60 dBSPL when the gain of the hearing instrument is at its full-on position.

Set RTS

An interactive dialog to set the Reference Test Setting, using the volume control on the DUT.

Frequency Response

Coupler SPL as a function of frequency for a 60 dB input SPL, with gain control at RTS.

Harmonic Distortion

Ratio of sum of the powers of all the harmonics to the power of the fundamental at various levels and frequencies.

Equivalent Input Noise

SPL of an external noise source at the input that would result in the same coupler SPL as that caused by all the internal noise sources in the hearing aid.

Battery Current

Electrical current drawn from the battery when the input SPL is 65 dB at 1000 Hz and the gain control is at RTS.

Input Output

For hearing aids with AGC, the coupler SPL as a function of the input SPL, at one or more of 250, 500, 1000, 2000, 4000 Hz, with the gain control at RTS

Attack and Release

Attack: For hearing aids with AGC, the time between an abrupt change from 55 to 90 dB input SPL and the time

when the coupler SPL has stabilized to within 3 dB of the steady value for a 90 dB input SPL, at one or more of 250, 500, 1000, 2000, 4000 Hz, with the gain control at RTS.

Release: For hearing aids with AGC, the time between an abrupt change from 90 to 55 dB input SPL and the time when the coupler SPL has stabilized to within 4 dB of the steady value for a 55 dB input SPL, at one or more of 250, 500, 1000, 2000, 4000 Hz, with the gain control at RTS.

SPLITS Response

For hearing aids with an inductive input coil (T-coil), the coupler SPL as a function of frequency when the hearing instrument, with gain control at RTS, is oriented for maximum output on a telephone magnetic field simulator (TMFS).

IEC60118-7

These IEC60118-7 measurements are supported:

OSPL90 curve

OSPL90 Curve measures coupler output sound pressure level (OSPL) as a function of frequency, for a 90 dB input SPL.

HFA OSPL90

HFA OSPL90 displays the high frequency average (average SPL at 1 kHz, 1.6 kHz and 2.5 kHz) for a 90 dB input SPL.

Full-On Gain

Full-On Gain (FOG) displays gain for an input of 50 dBSPL when the gain of the hearing instrument is at its full-on position.

HFA Gain

HFA Gain displays the HFA FOG for an input of 50 dBSPL when the gain of the hearing instrument is at its full-on position.

Set RTS

An interactive dialog to set the Reference Test Setting, using the volume control on the DUT.

Frequency Response

Coupler SPL as a function of frequency for a 60 dB input SPL, with gain control at RTS.

Battery Current

Electrical current drawn from the battery when the input SPL is 65 dB at 1000 Hz and the gain control is at RTS.

Equivalent Input Noise

SPL of an external noise source at the input that would result in the same coupler SPL as that caused by all the internal noise sources in the hearing instruement.

Harmonic Distortion

Ratio of sum of the powers of all the harmonics to the power of the fundamental at various levels and frequencies.

Input Output

For hearing aids with AGC, the coupler SPL as a function of the input SPL, at one or more of 250, 500, 1000, 2000, 4000 Hz, with the gain control at RTS.

Attack and Release

Attack: For hearing aids with AGC, the time between an abrupt change from 55 to 90 dB input SPL and the time when the coupler SPL has stabilized to within 3 dB of the steady value for a 90-dB input SPL, at one or more of 250, 500, 1000, 2000, 4000 Hz, with the gain control at RTS.

Release: For hearing aids with AGC, the time between an abrupt change from 90 to 55 dB input SPL and the time when the coupler SPL has stabilized to within 4 dB of the steady value for a 55 dB input SPL, at one or more of 250, 500, 1000, 2000, 4000 Hz, with the gain control at RTS.

ETLS

For hearing aids with an inductive input coil (T-coil), first find HFA-SPLI, the high frequency average SPL in a magnetic field. Subtract from this (RTG+60 dB) to find ETLS, the equivalent test loop sensitivity.

HFA MASL

Orient the hearing instrument in the magnetic field for maximum pick-up sensitivity, measure HFA output SPL and calculate MASL (magneto-acoustical sensitivity level).

Using the APxHITest API

Introduction

The APxHiTest DLL (HiTest.dll) is a class library used to aid in the development of user applications that will be used to test hearing instruments with APx500 and the APx511. Based on .NET, it can be used with C#, VB or LabVIEW.

A detailed Help file (HiTest_API_PRG.chm) for the API is provided via a shortcut in the Windows Start menu. Sample files are listed on page 34.

A Quick Tour of the DLL

The APxHITest DLL provides functions for making basic measurements that can satisfy ANSI or IEC requirements. It also provides for saving or restoring settings from file. The DLL provides all required communications with the APx API.

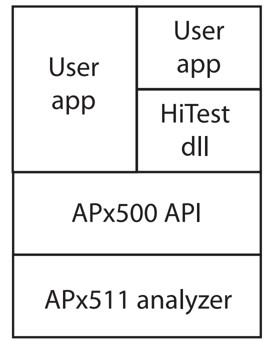
APx500 software must be installed and of the correct version.

The DLL and support files are installed with the APx program files, in a subfolder named HearingInstrumentTest.

A Layer View

The interaction of the different components of the system is based on layers of software on top of the APx511 Analyzer, as shown in the diagram below.

The first layer above the analyzer is the APx500 API. It provides a functional interface for access to the instrument and all of its measurement capabilities.



In the diagram, the second layer above the APx511 analyzer contains a user created application and the APxHiTest DLL. The HiTest DLL is designed to provide a simplified interface to the instrument that is tailored for hearing instrument testing.

The top layer in the diagram shows a user created application that is designed for testing hearing instruments. This top level application can access the APx511 analyzer completely through the HiTest DLL without any reference to the APx500 API. The APxHia application installed from the APx511 software disc is an example of such an application.

The user created application shown in the upper left corner of the diagram can access the APx511 analyzer through the APx500 API or through the HiTest DLL, or both. A sample use case for this would be an application to test hearing instruments that needs some of the more advanced features available in the APx500 API as well as the standard measurements available in the HiTest DLL. In this case, the application would reference the APx500 API as well as the HiTest DLL

Initialization

The first step in any application is to create an instance of the APxHiTest object. This is done in C# or VB by declaration and assignment.

C#.NET

```
Using AudioPrecision.HiTest;
Private APxHiTest apxHiTest;
// Create a new instance
apxHiTest = new APxHiTes();
```

VB.NET

```
Imports AudioPrecision.HiTest
Private apxHiTest As APxHiTest
' Create a new instance
apxHiTest = New APxHiTest()
```

The module will require access to the DLL, which should be referenced in the project. Once referenced, then a using statement will bring in the functionality of the dll. Within a class constructor, the call to declare an instance the APxHiTest can be made.

Once an object is created, it must be initialized

C#.NET

```
var r = apxHiTest.Initialize();
If (!r)
   // throw an initialization error or display
  // a messagebox.
```

VB.NET

```
Dim r as Boolean
' Initialize it
R = apxHiTest.Initialize()
If (r == False)
  // Initialize failed
```

The Initialize function will load the APx project file that is specific to the Hearing Instrument DLL. It is found in the SupportFiles folder of the installed directory for the DLL.

Configuration

The DLL provides file handling for the storing and retrieval of microphone calibration and speaker leveling. These files reside in a default directory. The location can be assigned for opening different files.

C#.NET

```
apxHiTest.ConfigurationFullPath = "myPath";

apxHiTest.RestoreConfiguration();
```

VB.NET

```
' Set the path to the target configuration
apxHiTest.ConfigurationFullPath = "myPath"
' Load the configuration
apxHiTest.RestoreConfiguration()
```

By setting ConfigurationFullPath, the application can bring in settings from different locations or save settings to folders other than the default folder.

Calibration

Two main areas are the focus of calibration. The microphone and must be calibrated and the speaker must be leveled for proper measurements to be made.

Microphone Calibration

The microphone may be calibrated with the use of a standardized calibrator that provides a known level, or entering the specifications from a microphone data sheet.

Calibration Technique	APXHITest Function Name
Using a calibrator	CalibrateMic (calibrator level, acceptable tolerance)
Using a data sheet	CalibrateMic (Signal path, spec in mV/Pa)
Measuring applied level	MeasureCalSPL (signal path, MeasSplType.ReferenceLevels)

The second CalibrateMic function (above) should be used to set the mic cal value for each signal path in the project, insuring that all signal paths are properly set up for the microphone.

Two methods provide status of the calibration by indicating if a calibration has been performed (by calling IsMicCalibrated), and the time of the last attempt (by calling MicCalibrationTimestamp). The time of the last calibration will reflect when it was last performed, regardless of its success.

Speaker Leveling

The system must determine what levels are required to generate a flat response through the speaker. This is accomplished by performing the leveling. It applies the full range of frequencies to the speaker and the microphone will capture the level at that frequency. The resultant table of frequencies and levels can be applied to the APx, so that future measurements using the speaker will have a flat response curve.

There is one function for performing this, called LevelAcousticPath. It takes several arguments. As a result of a successful leveling, the instrument will be loaded with the proper equalization table for each measurement used.

Calibration Persistence

Each time the APxHiTest is initialized, it will read in the calibration and leveling data from previous sessions. If there has been a change in either the microphone or speaker parameters, the data will be saved at the close of the APxHiTest.

Measurements

The supplied functions for performing measurements are written as such to allow a generalized use, where levels can be provided based on the needs of the specific test being performed.

For instance, to measure OSPL90, a call to MeasureFrequencyResponseLevel is made.

C#.NET

```
double level = 90.0;
SignalType sweep =
SignalType.FrequencyResponse;
SignalPath path = SignalPath.Acoustic;
APXHiTest.XYarrayPair results = apxHiTest.
MeasureFrequencyResponseLevel(level, path,
sweep);
```

VB.NET

```
' Declare a variable to hold the results
Dim ospl90 As APxHiTest.XYarrayPair
Dim path As APxHiTest.SignalPath
Dim signal As APxHiTest.SignalType
path = APxHiTest.SignalPath.Acoustic
signal = APxHiTest.SignalType.FrequencyResponse
' Call the measurement function on the Acoustic
path using Frequency Response
ospl90 =
apxHiTest.MeasureFrequencyResponseLevel(90.0,
path, signal)
```

The value returned from the call will be a structure containing two arrays, the X array is the list of frequencies, and the Y array is the list of levels found at each frequency. To complete the measurement, scan through the X array to find the index of the three HFA frequencies of 1.0K, 1.6K and 2.5K, and find the matching levels. Perform the average of the three levels and that is OSPL90;

Instrument Parameters

There are several functions that support the APx directly. With these functions, the version or serial number can be queried. Also the APx UI can be made visible or hidden. The signal monitors can be turned on or off.

C#.NET

```
// Hide the APx
apxHiTest.Visible = false;
```

VB.NET

```
' Make APx visible
apxHiTest.Visible = False
```

Closing

At the end of the application, before it exits, a call to close the dll should be made. If the Close function is called with True as its argument, then the AXP500 will shut down as well..

C#.NET

```
// Close the HiTest
apxHiTest.Close();
```

VB.NET

```
' Close the HiTest
apxhiTest.Close()
```

API Help File

Refer to the HiTest_API_PRG.chm help file available via a shortcut in the Windows Start menu.

Measurement Overview

To accomplish measurements that are in line with the ANSI standards, refer to the following table for guidelines of functions to call and what parameters to supply.

ANSI [IEC] Test Name	*ANSI [IEC] Level*	*HI Dut*	*APxHiTest Measurement Name*
OSPL90	90 dBSPL	At FOG	MeasureFrequencyResponseLevel
HFA OSPL90	90 dBSPL	At FOG	HfaMeasurement with HfaResultsType.HfaOSPL
Full On Gain	60 dBSPL [50]	At FOG	MeasureFrequencyResponseLevel
HFA Gain	60 dBSPL [50]	At FOG	HfaMeasurement with HfaResultsType.HfaGain
Set RTS	60 dBSPL	At FOG	HfaMeasurement with HfaResultsType.HfaGain
Frequency Response	60 dBSPL	At RTS	MeasureFrequencyResponseLevel
Harmonic Distortion	70 @ 500Hz, 70 @ 800 Hz, 60 @ 1.6kHz	At RTS	MeasureTHD
Equivalent Input Noise	50 dBSPL	At RTS	EinMeasurement
Battery Current	65 @ 10kHz	At RTS	MeasureBatteryCurrent
SPLITS [ETLS]	31.6 mA/m	At RTS and Telecoil	MeasureTelecoilSensitivity, and MeasureFrequencyResponseLevel for plot data
HFA MASL	10 mA/m	At FOG and Telecoil	MeasureTelecoilSensitivity
Input / Output	50 to 90 dBSPL in 5 dB steps	At RTS and Acoustic	InputOutputResponse
Attack / Release	50 and 90 dBSPL	At RTS and Acoustic	AttackAndRelease

Some measurements provide data as single values. Some metrics must be derived from the measurement results.

APxHiTest Graphics

Two measurement functions support capturing the plot screen as a bitmap that can be displayed by the application. They are MeasureFrequencyResponse and MeasureInput-Output. They make use of optional arguments beyond the required arguments. The default is to skip the screen capture. If a string file name is supplied, then the image will be stored in the named file with the dimensions of 640 by 480. The call can also include the x and y dimensions of the desired image size. The file name should be a fully qualified name of path and file name.

APxHiTest SignalType

Several of the measurements allow for a choice in the underlying test method. The caller can provide the selection. These are basically Chirp (or Frequency Response), Stepped Frequency Sweep, or Composite (Multitone).

Programming samples

We provide a number of programming samples to illustrate operating the APx511 in a production environment using the API.

The following sample files and documentation are provided on the included CD-ROM, “APx511 Resources Disc”, AP part number 8411.1780. These files are typically installed in the user area, e.g. ~\User Docs\APx500 3.3|HI Analyzer

Sample Files

The content of the C# and VB solutions and files and the LabVIEW VIs is similar, providing the same capabilities.

C#.NET solutions and files

These are typically installed in ~\User Docs\APx500 3.3|HI Analyzer\Examples\CSharp. Specific documentation can be found in the interactive help available while running the solution in Visual Studio, or in the Help file HiTest_API_PRG.chm.

VB.NET solutions and files

These are typically installed in ~\User Docs\APx500 3.3|HI Analyzer\Examples\VBNET. Specific documentation can be found in the interactive help available while running the solution in Visual Studio, or in the Help file HiTest_API_PRG.chm.

LabVIEW VIs

These are typically installed in ~\User Docs\APx500 3.3|HI Analyzer\Examples\LabVIEW. Specific documentation can be found within the LabVIEW VIs.

Documentation

Documentation is provided for general use of the APx500 API and for the specific use of the functions in HiTest.dll. Within this document (APx511_Installation_Specifications_and_Getting_Started_Guide.pdf), see Using the APx-HiTest API on page 29, and APxHia on page 24. Installed from the CD-ROM, you’ll also find

- **Getting Started with the APx API.pdf** (general)
- **HiTest_API_PRG.chm** (a Help file containing the same content as the C#.NET and VB.NET Help available when running the sample files in Visual Studio.)

Running Self Test

APx511 Self Test Kit (Self Test Fixture, cable and terminator.

Audio Precision provides a group of “Self Test” APx projects, under control of a program called SelfTest.exe. Download Self Test from http://www.ap.com/download/archive/534. Be sure to select the Self Test for the version of APx500 you are currently running. Instructions are in the ReadMe.txt file included in the Self Test zip file.

For the APx511, a special fixture is required to connect the APx511 outputs to its input, and to provide proper loading and termination. This fixture with a cable and a terminator are in the SLFT-KIT, available from Audio Precision.

Plug the DB-15 connector on the self test fixture directly into the DB-15 connector on the APx511 rear panel. Connect the BNC cable and the 75 Ω terminator as directed by prompts in SelfTest.exe.

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ap.com